

What is claimed is:

1. A self-mode locked multi-section semiconductor laser diode, comprising:
a complex-coupled DFB laser section that includes a complex-coupled grating
and an active structure for controlling the intensity of oscillating laser light, to oscillate
5 laser light in a single mode; and
an external cavity including a phase control section and an amplifier section, the
phase control section having a passive waveguide that controls a phase variation of
feedback laser light, the amplifier section having an active structure that controls the
strength of the feedback laser light, the DFB laser section and the external cavity being
10 monolithically integrated on a single substrate, current being independently injected into
each of the sections.

2. The self-mode locked multi-section semiconductor laser diode as claimed
in claim 1, wherein the laser diode has a buried heterostructure.

3. The self-mode locked multi-section semiconductor laser diode, as claimed
in claim 1, wherein the laser diode has a ridge structure.

4. The self-mode locked multi-section semiconductor laser diode as claimed in claim 1, wherein the complex-coupled grating of the DFB laser section is a loss-coupled grating constructed in a manner in which a diffraction grating is formed in an additional absorptive layer, which longitudinally periodically varies both effective
5 refractive index and loss.

5. The self-mode locked multi-section semiconductor laser diode as claimed in claim 1, wherein the complex-coupled grating of the DFB laser section is a gain-coupled grating constructed in a manner in which a diffraction grating is formed in an
10 active structure, which longitudinally periodically varies both effective refractive index and gain.

6. The self-mode locked multi-section semiconductor laser diode as claimed in claim 1, wherein each of the active structures included in the DFB laser section and
15 the amplifier section is formed in a manner in which a first light guiding layer, an active layer, and a second light guiding layer are sequentially deposited.

7. The self-mode locked multi-section semiconductor laser diode as claimed in claim 6, wherein each of the first and second light guiding layers is formed of InGaAsP having a band gap of $1.3\mu\text{m}$ and has a thickness of 70nm, and the active layer has a multi-quantum-well structure with a band gap of $1.55\mu\text{m}$ including wells and
5 barriers according to InGaAsP.

8. The self-mode locked multi-section semiconductor laser diode as claimed in claim 6, wherein each of the first and second light guiding layers is formed of InGaAsP having a band gap of $1.3\mu\text{m}$ and has a thickness of 70nm, and the active layer
10 is formed of InGaAsP having a band gap of $1.55\mu\text{m}$.

9. The self-mode locked multi-section semiconductor laser diode as claimed in claim 1, wherein the guiding layer of the phase control section is arranged through butt-coupling such that its central axis accords with those of the active structures.

15 10. The self-mode locked multi-section semiconductor laser diode as claimed in claim 9, wherein the guiding layer has a thickness of 400nm and is made of InGaAsP having a band gap of $1.3\mu\text{m}$.

11. The self-mode locked multi-section semiconductor laser diode as claimed in claim 1, wherein the DFB laser section, the phase control section, and the amplifier section are constructed through evanescent-coupling in which the sections have a common guiding layer.

12. The self-mode locked multi-section semiconductor laser diode as claimed in claim 1, wherein the phase control section is located between the DFB laser section and the amplifier section.

13. The self-mode locked multi-section semiconductor laser diode as claimed in claim 1, wherein the amplifier section is located between the DFB laser section and the phase control section.

14. The self-mode locked multi-section semiconductor laser diode as claimed in claim 1, wherein the facet of the DFB laser section is coated with an anti-reflection film, whereas the facet of the external cavity, opposite to the facet of the DFB laser region, is coated with a high-reflection film or is left as cleaved.